

1502/15 21 96 4

Rec'd PCT/PTO 21 JAN 2005

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property  
Organization  
International Bureau



(43) International Publication Date  
29 January 2004 (29.01.2004)

PCT

(10) International Publication Number  
**WO 2004/009910 A2**

- (51) International Patent Classification<sup>7</sup>: **E02B 3/14**
- (21) International Application Number:  
PCT/NL2003/000541
- (22) International Filing Date: 24 July 2003 (24.07.2003)
- (25) Filing Language: Dutch
- (26) Publication Language: English
- (30) Priority Data:  
1021146 24 July 2002 (24.07.2002) NL
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- (81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
- Published:**  
— without international search report and to be republished upon receipt of that report
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

(54) Title: PROTECTIVE ELEMENT FOR A BREAKWATER OR WAVE-RETARDING CONSTRUCTION

(57) Abstract: A protective element for a breakwater or wave-retarding construction comprises a body that has at least two opposing projections. The projections are on either side of a flat base and extend transversely thereto. The periphery of the base is non-circular, so that rolling of the protective element under the influence of the beating of the waves is resisted.

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Protective element for a breakwater or wave-retarding construction

The invention relates to a protective element for a breakwater or wave-retarding construction, comprising a concrete body that has at least two opposing projections.

5 A protective element of this type is disclosed in NL-A 8903138. Such protective elements are intended for the parts of, for example, breakwaters, dams and the like that are exposed to the beating of the waves. The waves break as soon as they strike the protective elements, with the result that the underlying parts are better protected against the forces of the water.

10 The protective elements are usually made of concrete. Usually no reinforcement is used on the grounds of durability. Although a reinforcement has a beneficial effect on the strength of the protective element, it nevertheless has the disadvantage that rusting can hardly be prevented, especially in a salty environment. This means that the strength of the protective element has to be provided by the concrete material alone. It is therefore  
15 necessary to choose as advantageous as possible a shape for the protective element. Despite the lack of reinforcement, it must nevertheless be possible to ensure adequately high strength by this means.

The aim of the invention is therefore to provide a protective element of the abovementioned type that has an as advantageous as possible cohesion and strength. Said  
20 aim is achieved in that the projections are on either side of a flat base and extend transversely thereto. Preferably, the projections are in the middle of the base. Furthermore, they can have all conceivable shapes; a cylindrical shape and a conical shape are mentioned as examples.

The projections are preferably oriented perpendicularly with respect to the base.  
25 Furthermore, the base can have at least one auxiliary projection at the periphery which extends parallel to or in line with the base.

The base as well can have various shapes. A non-circular shape, such that the protective element will not easily start to roll under the influence of the water forces, is preferred. The base is preferably polygonal, preferably rectangular, pentagonal or  
30 hexagonal. For ease of production a peripheral shape based on a regular polygon is preferred. There can be an auxiliary projection at each corner of the base.

Just like the base, a projection can have various peripheral shapes. A non-circular shape is preferred because of the resistance to rolling. The periphery of a projection is

preferably polygonal. One possibility is that the periphery of a projection is a regular polygon, just like the periphery of the base. If the peripheral shapes are of identical shape, in the case of a polygon with  $n$  corners the preference is that the polygon of the projection is turned through the order of  $360/2n$  degrees of an arc with respect to the polygon of the base.

Another preferred embodiment for the shape of the projection is that the end terminates in a flat surface. In this context it is preferable that this surface is virtually perpendicular to a longitudinal axis of the projection.

The material from which the element is made is preferably concrete, which contains at least cement, sand, granulate or gravel and optionally hardeners and/or plasticisers. Another preferred embodiment of the material is a material that at least consists of a residue from oil refining, sand, rock-like granulate or gravel. Such a material is known under the trade name C-Fix<sup>®</sup>. This can be compared with a sort of cement-bound concrete, where the cement has been replaced by a residue from oil refining, the melting point of which is above 150 °C.

A possible method for producing a protective element using this material is as follows. The material is heated to above the melting point of the residue material from oil refining. This material is introduced into individual shuttering or casting moulds for the base or projections, after which said material is allowed to cool. A protective element is then assembled by locally heating the joining end of a projection and the joining location on the base. The projection and base are then brought together and the join is allowed to cool, as a result of which a permanent join is produced.

Another preferred embodiment of the base of the protective element is that this has two parallel surfaces.

Another possibility for production of a protective element is to produce this in a split shuttering. For this purpose a raised area is made on the ground, after which a split box is placed on this elevation. This box split by a vertical plane has a bottom box which is open at the top and the bottom. The open bottom fits over the elevation in a sealed manner. A top box is attached to the bottom box, which top box can be moved relative to the bottom box.

Material for the element is poured via the open top of the bottom box, as a result of which the base and at least a bottom projection is formed, the bottom of this projection being on the elevation. After the material has set to some extent, material is poured into the

top box for the top projection. After all the material has set, the top box is raised a short distance using lifting means, which are between the bottom box and top box, for freeing the material and the box. The bottom box is then lowered a short distance, which is less than the distance travelled by the top box, to free the box. This lowering is effected by known  
5 lifting means in the support means, such as legs which are provided with threaded adjustment means. These legs are located below each part of the bottom box. The closure means between the parts of the split box are then unlocked and the parts of the bottom box are removed together with their top box. The box can then be re-used.

10 The invention will be explained in more detail below with reference to a few illustrative embodiments shown in the figures.

Figure 1 shows a perspective view of the principle of a protective element according to the invention.

Figure 2 shows, diagrammatically, an example of the use of the protective element.

15 Figure 3 shows a perspective view of a first illustrative embodiment of the protective element according to the invention.

Figure 4 shows a plan view of the element according to Figure 1.

Figure 5 shows a side view of the element according to Figure 1.

Figure 6 shows a further embodiment of the protective element according to the invention.

20 Figure 7 shows a possible production method.

Figure 8 shows a possible variant of split shuttering for the production of a protective element.

25 Figure 1 shows the basic principle of a plate-shaped base 1 and top and bottom projections 2 and 3, respectively. Figure 2 shows protective elements which are situated on an incline of a breakwater.

The protective element for a breakwater shown in Figures 3 - 5 comprises a plate-shaped base 1, indicated in its entirety by 1, on either side of which projections 2 and 3 extend perpendicularly. The base 1 is essentially rectangular and at the four corners has projections 4 which have a pointed shape determined by the sloping surfaces 5, 6.

30 The projections 4 define recesses 7 between them, through which the water is able to flow freely. The polygonal, in this case square, shape of the base body 1 guarantees high stability.

The base 1 has two surfaces 8, 9 facing away from one another which are parallel to

one another.

In the embodiment in Figure 4 a plan view is shown of a hexagonal protective element provided with two hexagonal projections 2 (one can be seen in Figure 4) as well as six projections 6.

5 Figure 7 shows a possible method for the production of a protective element according to the invention. For this purpose a first recess 11, defined by shuttering 12, is made in a substrate 20. A first quantity of concrete 13 is poured into this shuttering 12, up to ground level 10, to form a first projection of the protective element to be produced.

10 A second shuttering 14 is produced on the ground 10, into which a second quantity of concrete 15 is then poured to produce the base. It is also possible to wait until the second shuttering 14 has been produced on the ground 10 before pouring the first quantity of concrete 13. The quantity of concrete 13 and 15 can then be poured in a single operation, as a result of which the bottom projection and the base are produced at the same time.

15 After this base has set to some extent, third shuttering 16 is placed on top of this to receive a quantity of concrete 17 that is to form the top projection.

After the quantities of concrete 13, 15, 17 have set, the protective element is complete.

Figure 8 shows another shuttering for the production of an element from Figure 3 - 5. This shuttering consists of two halves split by a vertical plane. Figure 8a shows a box in the closed state, in which the element will be released from the box. The bottom box 21 consists of a left-hand bottom box 23 and a right-hand bottom box 24, which are open at the top and at the bottom. The top box 22 connected to the bottom box 22 by the connecting means 29 consists of a left-hand top box 25 and a right-hand top box 26. Lifting means are incorporated in the connecting means 29 to enable the top box to be lifted with respect to the bottom box. At least three support means 30 are positioned below the bottom box, which support means can be provided with wheels. Known lifting means are incorporated in the support means 30 to enable the bottom box to be lowered. The bottom of the top box is provided with a left-hand and a right-hand apron 27 and 28, respectively, which lies on the top of the poured material for the base of the element and ensures good abutment and correct rounding-off between base and top projection. The poured element 1 with the left-hand and right-hand half of the shuttering removed can be seen in Figure 8b.

Claims

1. Protective element for a breakwater or wave-retarding construction, comprising a body that has at least two projections (2, 3), characterised in that the body consists of a plate-shaped base (1), from the two plate sides of which the projections (2, 3) extend.

2. Protective element according to Claim 1, wherein the projections (2, 3) are in the middle of the base (1).

3. Protective element according to Claim 1 or 2, wherein the projections (2, 3) are in the extension of one another.

4. Protective element according to Claim 1, 2 or 3, wherein the projections (2, 3) are oriented perpendicularly with respect to the base (1).

5. Protective element according to one of the preceding claims, wherein the base (1) has at least one auxiliary projection (4) at the periphery, which auxiliary projection extends parallel to or in line with the base (1).

6. Protective element according to one of the preceding claims, wherein the periphery of the base (1) is non-circular.

7. Protective element according to Claim 6, wherein the periphery of the base (1) is square or rectangular.

8. Protective element according to one of Claims 1 - 6, wherein the periphery of the base (1) is polygonal.

9. Protective element according to Claim 8, wherein the periphery of the base (1) is a regular polygon.

10. Protective element according to Claim 7, 8 or 9, wherein there is an auxiliary projection (4) at each corner of the base (1).

11. Protective element according to one of the preceding claims, wherein the periphery of a projection (2, 3) is non-circular.

5        12. Protective element according to Claim 11, wherein the periphery of a projection (2, 3) is polygonal.

13. Protective element according to Claim 12, wherein the periphery of a projection (2, 3) is a regular polygon.

10

14. Protective element according to preceding Claims 1 - 13, wherein both the periphery of the base (1) and of a projection (2, 3) is a regular polygon.

15        15. Protective element according to Claim 14, wherein a regular polygon, with n corner points, of a projection (2, 3) is of identical shape to a regular polygon of the base (1) and that the polygon of said projection (2, 3) is turned through the order of 360 divided by 2n degrees of an arc with respect to the polygon of the base (1).

20        16. Protective element according to one of Claims 11 - 15, wherein the end of a projection terminates in a flat surface.

17. Protective element according to one of the preceding claims, wherein the material from which the element is made is concrete.

25        18. Protective element according to one of Claims 1 - 16, wherein the material from which the element is made comprises at least a residue material from oil refining, sand, rock-like granulate or gravel.

30        19. Protective element according to one of the preceding claims, wherein the base (1) has two parallel surfaces (8, 9).

20. Method for the production of a protective element according to one of the preceding claims, comprising the following steps:

- creating a first cavity (11) in a substrate (20) provided with shuttering (12) for a first projection (2),

- optionally pouring concrete into the first shuttering (12),

- creating a second shuttering (14) on the ground (10) above the first shuttering (12),

5 - pouring concrete (15) into the second shuttering (14) on the ground (10) and the previously poured concrete (13) for the first projection, or simultaneously pouring concrete (13) into the first shuttering (12) and pouring concrete (15) onto this and the ground in the second shuttering (14),

10 - allowing the quantity of concrete (15) in the second shuttering (14) to set to some extent,

- placing a third shuttering (16) on the concrete (15), set to some extent, within the second shuttering (14).

- pouring a quantity of concrete (17) into the third shuttering (16) to form the second projection.

15

21. Method for the production of a protective element according to one of Claims 1 - 19, wherein the material at least consists of a residue material from oil refining, sand and rock-like granulate, comprising the following steps:

- separate production of base (1) and projections (2, 3) by:

20

- heating said material to above the melting point of the said residue material,

- pouring the material into a shuttering,

- allowing the material to set by allowing it to cool;

25 - locally heating the joining end of a projection (2, 3) at the same time as locally heating the base (1) at the joining location for said projection (2, 3) to above the melting point of the residue material,

- bringing said projection (2, 3) and the base (1) together at their joining location and then allowing the heated portion of the material to cool, as a result of which a permanent join is produced.

30

22. Method for the production of a protective element according to one of Claims 1 - 19, comprising the following steps:

making a raised area on the ground (10) this area having a cross-section that corresponds to the cross-section of a bottom projection,



- fitting a split bottom box (21), which is open at the bottom and open at the top, on the raised area together with a split top box (22) connected to the bottom box (21),

- pouring the material for the element into the bottom box (21),

- allowing this material to set to some extent,

5 - pouring the material into the top box (22),

- allowing the material to set, after which the top box is moved upwards a short distance such that the top box is freed from the material,

- lowering the bottom box (21) a short distance, which is less than the distance travelled by the top box (22), such that the bottom box (21) is freed from the material,

10 - removing one half of the bottom box (23) with top box (25) and then the other half of the bottom box (24) with top box (26), after which bottom box (21) together with the top box (22) can be re-used for the production of a subsequent element.

23. Shuttering for the production of a protective element according to one of  
15 Claims 1 - 19, which consists of a bottom box (21) split in a vertical plane, with a left-hand bottom box (23) and a right-hand bottom box (24), and a top box (22) split in the same vertical plane and connected to the bottom box (21), wherein the bottom box is open at top and bottom and can be placed with the bottom over an elevation in a sealed manner and that the top box (22) is connected to the bottom box (21) by connecting elements, wherein  
20 lifting means are incorporated in said connecting elements so as to raise the top box (22) with respect to the bottom box (21) and wherein the bottom box (21) is supported by support means, for example mobile legs, which are provided with lifting means so as to lower the bottom box together with the top box.

Fig 1

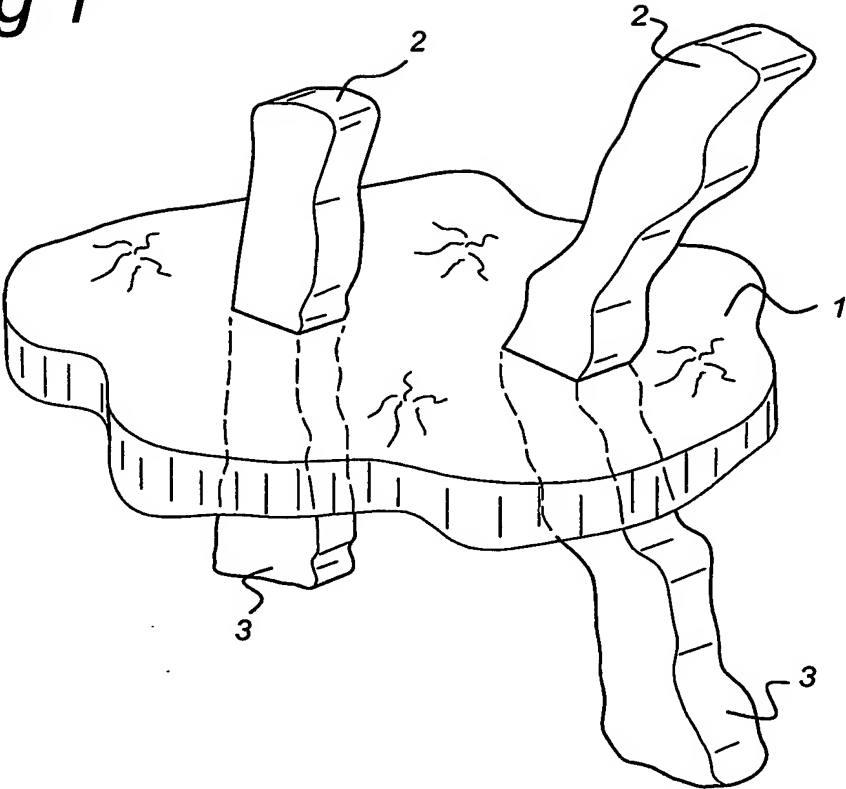


Fig 2

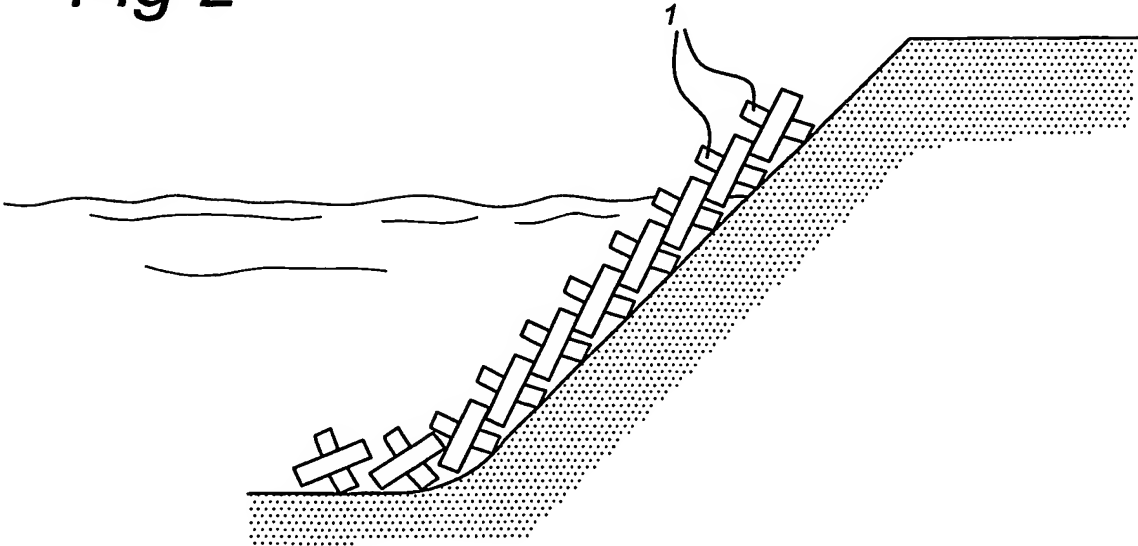


Fig 3

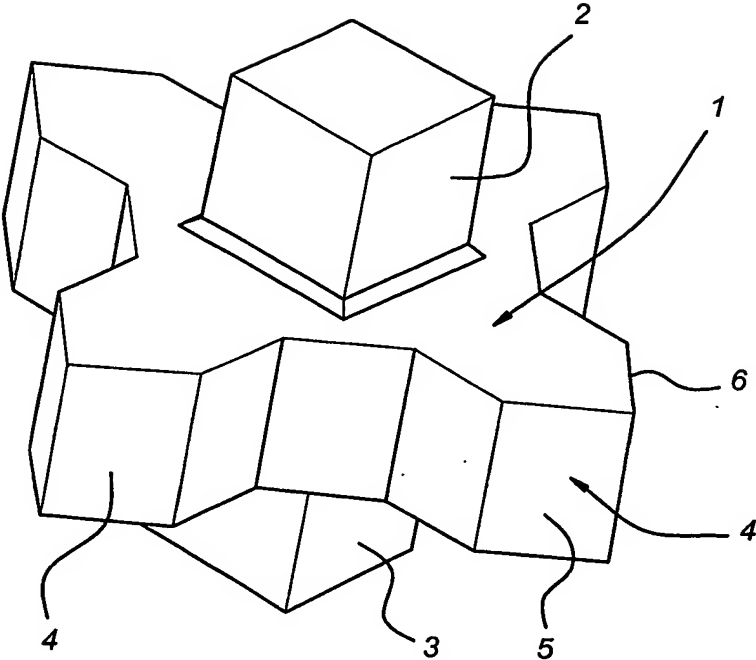


Fig 4

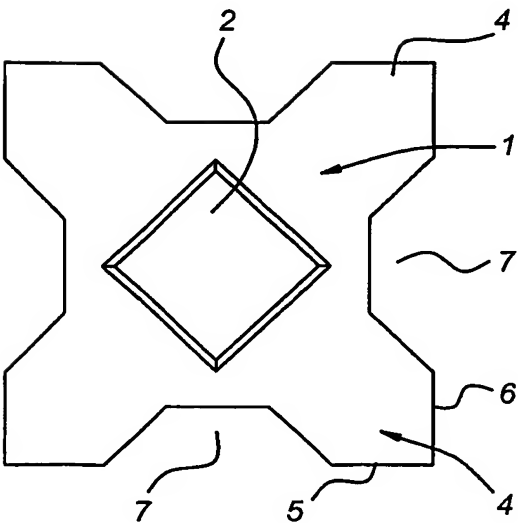
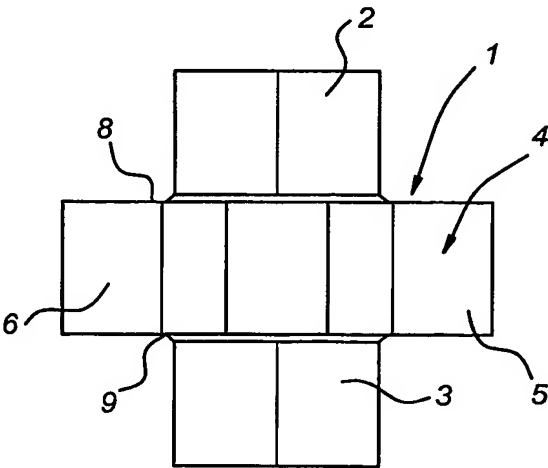
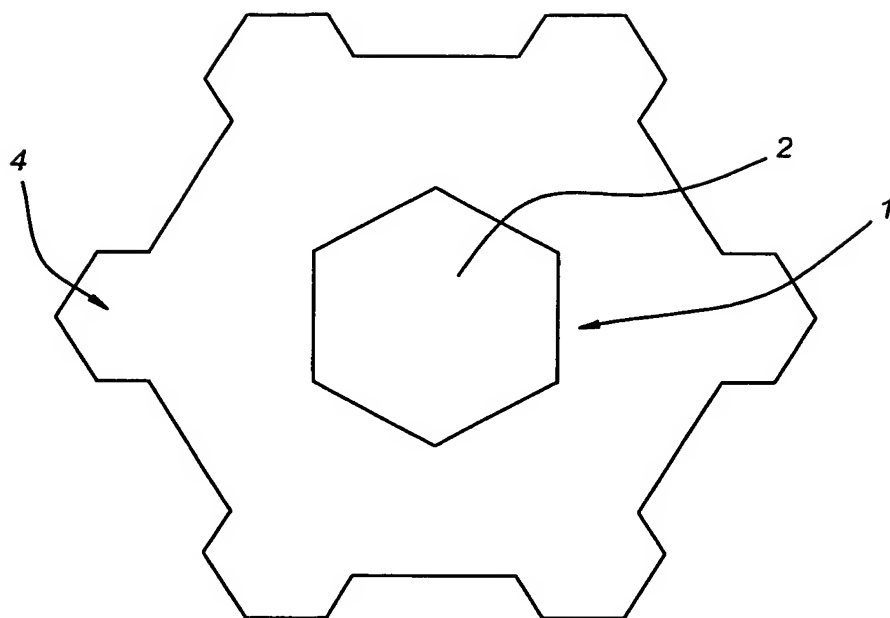
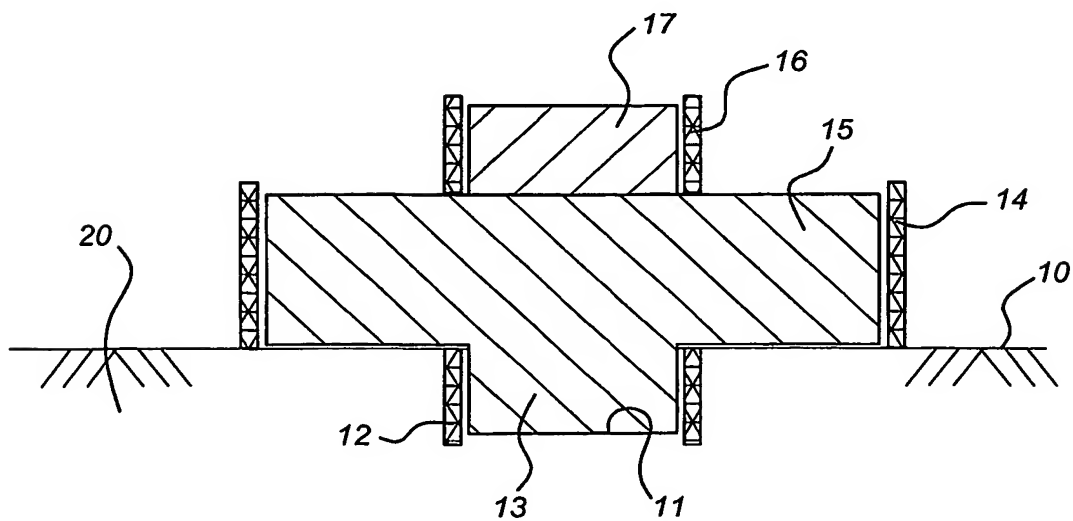
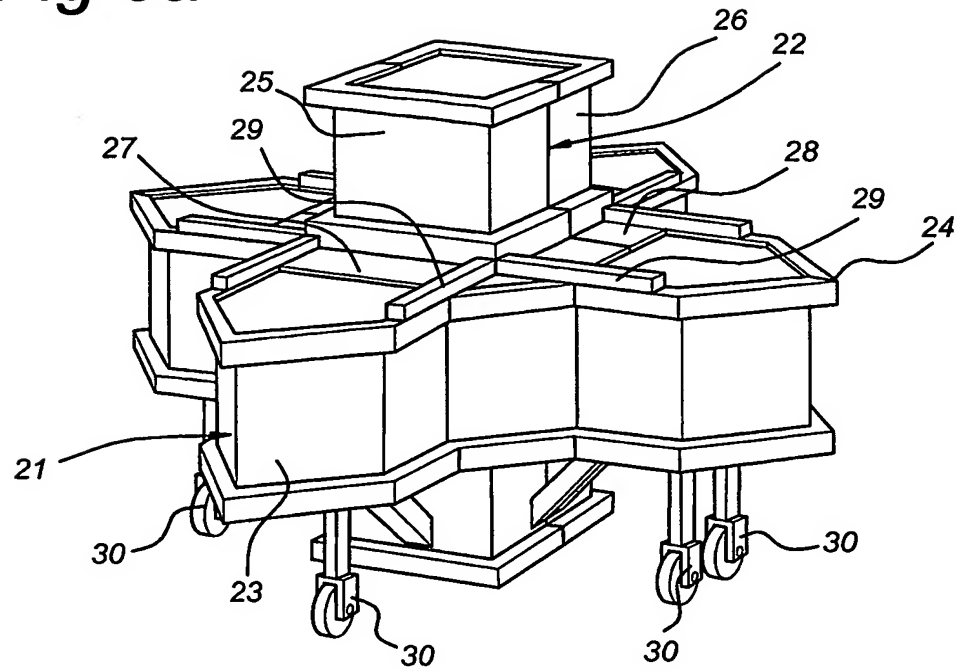
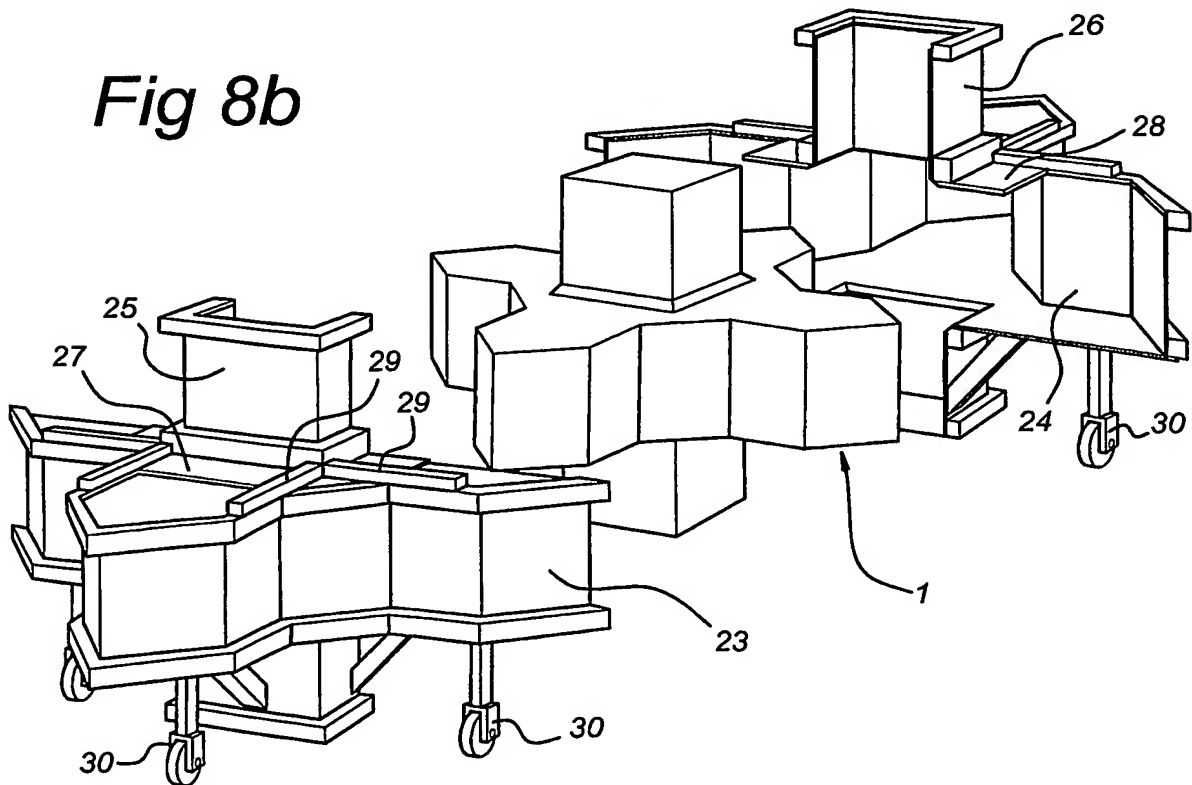


Fig 5



*Fig 6**Fig 7*

*Fig 8a**Fig 8b*

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property  
 Organization  
 International Bureau



(43) International Publication Date  
 29 January 2004 (29.01.2004)

PCT

(10) International Publication Number  
 WO 2004/009910 A3

(51) International Patent Classification<sup>7</sup>: E02B 3/14, 3/12,  
 B28B 7/00, C04B 26/26, C08L 95/00

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(21) International Application Number:  
 PCT/NL2003/000541

(22) International Filing Date: 24 July 2003 (24.07.2003)

(25) Filing Language: Dutch

(26) Publication Language: English

(30) Priority Data:  
 1021146 24 July 2002 (24.07.2002) NL

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 dijk 97, NL-3021 AE Rotterdam (NL). MUTTRAY,  
 Markus [NL/NL]; Geerpolderweg 4, NL-2807 LS Gouda  
 (NL).

(81) Designated States (national): AE, AG, AL, AM, AT, AU,  
 AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU,  
 CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH,  
 GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC,  
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 MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC,  
 SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA,  
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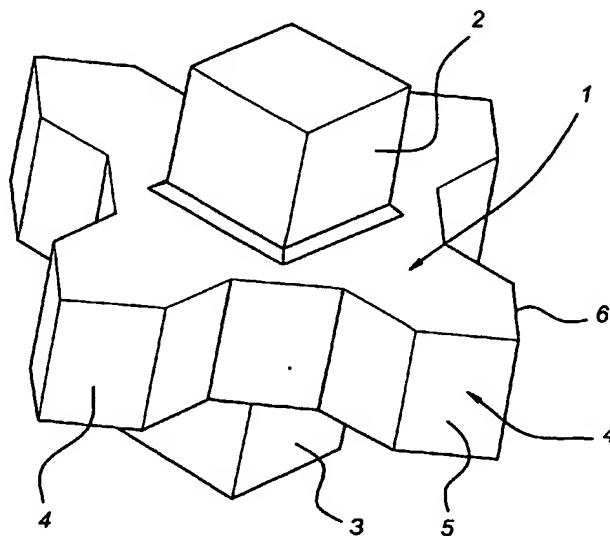
(84) Designated States (regional): ARIPO patent (GH, GM,  
 KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW),  
 Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),  
 European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE,  
 ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO,  
 SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM,  
 GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report

[Continued on next page]

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WO 2004/009910 A3



— before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(88) Date of publication of the international search report:  
22 April 2004

# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/NL 03/00541

A. CLASSIFICATION OF SUBJECT MATTER		
IPC 7	E02B3/14	E02B3/12 B28B7/00 C04B26/26 C08L95/00
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
IPC 7 E02B E01C B28B B29C C04B C08L		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the International search (name of data base and, where practical, search terms used)		
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C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 614 866 A (KANEKO TAISUKE) 26 October 1971 (1971-10-26)	1-14, 16, 17, 19
A	column 2, line 43 - column 3, line 16; figures 1-3	21, 22
X	US 4 347 017 A (CHEVALLIER) 31 August 1982 (1982-08-31)	1-12, 16, 17, 19
A	column 2, line 43 - column 4, line 26; figures	13, 14, 22, 23
X	US 3 759 043 A (TOKUNAGA) 18 September 1973 (1973-09-18)	1-8, 10-12, 16, 17, 19
A	column 1, line 6 - line 8  column 5, line 1 - line 15 column 5, line 59 - line 65 figures 1, 22	9, 13, 14, 23
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Date of the actual completion of the International search		Date of mailing of the International search report
22 January 2004		09.02.2004
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016		Authorized officer  Van Bost, S



## INTERNATIONAL SEARCH REPORT

Int. Patent Application No  
PCT/NL 03/00541

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,A	E.E.T.: "Project C-Fix wil tweede fase in" DIGITALE NIEUWSBRIEF VAN HET PROGRAMMA E.E.T., 'Online! no. 5, 27 March 2003 (2003-03-27), XP002267789 Retrieved from the Internet: <URL:http://www.eet.nl/nieuws/Nwsbrf5_2003.htm> 'retrieved on 2004-01-22! the whole document ----	1,18,21, 22
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A	US 5 879 105 A (BISHOP) 9 March 1999 (1999-03-09) column 5, line 21 - line 29 figures 2,3 ----	15
A	US 4 902 166 A (BORES) 20 February 1990 (1990-02-20) column 5, line 11 - line 33 figure 20 ----	20
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A	FR 2 734 292 A (BEC FRERES) 22 November 1996 (1996-11-22) page 6, line 18 -page 9, line 19 figures -----	22,23

# INTERNATIONAL SEARCH REPORT

ational application No.  
PCT/NL 03/00541

## Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

### Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-17, 19, 20

protective element characterised by its form and in situ-method of making same

2. Claims: 1,18,21

protective element characterised by consisting of residue material and method of making same

3. Claims: 22, 23

prefabrication-method for a protective element characterised by the use of a split-shuttering and split-shuttering used in said method

# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/NL 03/00541

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